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Treatment Manual

Equipment

Contents

Thermal Conductivity Gas Analyzers

Fumiscope and Gow-Mac

The thermal conductivity gas analyzer (T/C units) is a scientific instrument specifically designed for determining the concentration of gases within a chamber or other enclosure while the actual fumigation is being conducted. These fumigation gases include methyl bromide, and sulfuryl fluoride. The following discussions relating to the T/C unit are under these subheadings:

- Description
- Standardizing the instrument
- Operational procedures
- Repair and calibration
- Maintenance

Description

The Fumiscope® or Gow-Mac® is light in weight, portable, completely contained in a compact metal cabinet. It contains a thermal conductivity cell, scale, gas pump, range switch, and gas flow meter. A gas drying tube is also included. For large enclosures, an auxiliary pump may be needed.

Inlet This tube connector is the gas inlet for the instrument. The sampling tubes are connected directly to the inlet or through the drying tube.

Flow Rate Meter Indicates the gas flow rate in “simulated cubic feet per hour (SCFH).” Note: The flow rate should always be read at the middle of the ball.

Flow Rate Adjustment This dial controls the air or gas flow rate by adjusting the pump. After connecting to the gas sampling tube, the flow rate should be adjusted upward until it reads exactly 1.0. The gas concentration reading should be taken only after the meter that registers “ounces per thousand cubic feet” stabilizes, which may take a minute or more (depending upon the length of the tubing and whether or not an auxiliary pump is being used).

Scale Indicates the concentration of the MB fumigant in ounces per 1,000 cubic feet (milligrams per liter or grams per cubic meter). For some fumigants, the concentration is calculated as the reading times a specific factor.

Zero Adjustment This dial controls the scale needle which is brought to zero as an air sample is being drawn through the instrument.

Line Switches Control electrical supply to pump and scale.

Range Switch Regulates the scale indicating the concentrations of fumigant measured, for example, 0-100 ounces per 1,000 cubic foot or as 0-400 ounces per 1,000 cubic foot (some models). Digital models can indicate a range from 0-999 ounces per 1,000 cubic feet.)

Exhaust Outlet Always connect a tube to exhaust outlet to carry exhaust gas away from the instrument and operator. When using the T/C unit in confined or poorly ventilated areas, recirculate the exhaust gas back to the fumigation space or exhaust it to the outside.

Drying Tube The drying tube (filter tube) is for use with a prepared chemical for removal of certain contaminant gases or vapors which interfere with correct readings of fumigant concentration. For most fumigations, the tube will contain a desiccant such as Drierite® (granules of anhydrous calcium sulfate), and/or Ascarite® (sodium hydroxide). Both are available from scientific supply houses. The tube is inserted in the gas sampling line just before the inlet connection. Drierite®, blue in color when dry, turns pink when moisture is absorbed. When most of the desiccant has turned pink, it should be replaced. In extremely high moisture conditions, two tubes can be connected in tandem. Drying tube openings should be closed when not in use.

When a drying tube is used, a thin layer of glass wool or aquarium filter wool should be placed at the bottom and top of the tube to prevent small particles from sifting into the Fumiscope®. The use of absorbent cotton or similar materials is not recommended. Cotton tends to pick up moisture and to become matted, and once matted, the cotton may restrict normal air flow, thus adversely affecting the T/C unit's operation. (Matting may also cause the flow of air to bypass, rather than flow through the Drierite®.)

Mount the drying tube *vertically* so that the gas mixture moves through the drying material and does not pass over the top. This happens when the tube is mounted horizontally (lengthwise).

Commodities that are actively respiring produce carbon dioxide gas that may interfere with the correct readings of fumigant concentration.

During a fumigation of living plant products, such as plants, plant material, los, wood and wood products, tubes containing Ascarite® must be used to remove carbon dioxide from gas samples. Used filtering material should be discarded. The Ascarite® tube should be connected between the Drierite® tube and the sample inlet. In no instance should Drierite® and Ascarite® be mixed in the same tube. Ascarite® should be replaced when the granules begin to aggregate or become moist.

It is always advisable to use Drierite® when taking concentration readings of SF or MB. Desiccant should be fresh and frequently changed to ensure correct readings. *Never* use Ascarite® when making readings of SF because a chemical reaction will occur.

Standardizing the Instrument

Standardizing the instrument is the first and basic operation. Do the following to standardize the instrument.

1. Connect the instrument to an electrical outlet with proper voltage and set the pump and meter switches to "on." If inoperable, check fuse. (Replacements—Little Fuse or Buss #3AG 1/2 Amp.—should be kept on hand.)
2. Attach the drying tube to the inlet port. The instrument should be given a tightness test. This can be accomplished by placing a finger over the inlet of the drying tube. The flow ball in the flow meter should then fall to zero if the tubing and connections are tight.
3. Warm up the instrument for 15 to 30 minutes.
4. Adjust the gas flow rate to 1 cubic foot per hour (CFH) by adjusting the flow rate knob. If the flow rate knob is turned counter clockwise too far, the pump will emit noises and cease to operate properly. When properly adjusted, the flow ball should float at the center mark or slightly below on the calibrated glass cylinder. Slight fluctuations from a stationary position may occur. Dry, fresh air is now being drawn through the T/C cell by means of the pump, the air entering via the inlet on the face of the instrument, passing through the cell, and leaving through the exhaust outlet.
5. Turn the zero adjustment knob to obtain a zero reading on the meter. Several additional adjustments during the first few minutes may be necessary to obtain a stable zero reading. A check of the meter needle should be made periodically to determine if there is any sticking of the needle. A check is done by slowly turning the adjustment knob clockwise. A clockwise turn will swing the needle from 0 to 100/200 on the meter scale. A counterclockwise twist will return the needle to zero.

Standardization is now complete and readings can be made of fumigant-air mixture drawn through the unit. It may be necessary to replace the desiccant at this point.

The difference in the thermal conductivity of the fumigant-air mixture as compared with fresh air is measured electrically and indicated on the meter as concentration readings in ounces of MB per 1,000 cubic

feet. T/C units used in PPQ must be calibrated for MB by the manufacturer or an outside contractor prior to use. You will not get accurate readings when fumigations are under even a small vacuum.

The Gow-Mac® T/C units used by PPQ are equipped to measure MB concentrations up to 400 ounces per 1,000 cubic feet. Since the T/C unit's galvanometer responds linearly to gas concentrations, the MB calibrated instrument may be used for measuring certain other gases by the use of specific multiplication factors determined for each instrument.

Operational Procedures

The proper use of the Fumiscope® is discussed under two headings:

- Selecting Operational Site for the T/C Unit
- Measuring Gas Concentrations With the Standardized Unit

Because of the variety of fumigation situations, some adjustments may be necessary to meet specific needs. Nevertheless, this outline should be helpful in establishing correct operational procedures.

Selecting Operational Site for the T/C Unit

The T/C unit should be close enough to the fumigation site to avoid the use of unreasonable lengths of sampling tubes, to allow for constant surveillance of the fumigation during testing, and to avoid interference with other activities in the area. It should be at a sufficient distance from the fumigation site (at least 30 feet up-wind) to allow the operator to function without the fear of accidental exposure to gas and to allow for easy exit in an emergency. Excessive wiring length should be avoided. When T/C unit readings in multiple locations are necessary, care should be taken to see that each location is the best available.

The T/C unit should be supported on a sturdy, level surface, outside the traffic pattern and protected from wind, rain, excessive cold, and sun in hot weather. Temporary shelter such as a tarpaulin cover may be adequate in some cases. The gas concentration readings indicated by the T/C unit may be inaccurate unless the unit is placed in an area that is approximately the same temperature as the gas mixture in the enclosure being fumigated. Temperature differential may cause moisture to condense inside the gas sampling line.

Most T/C units operate on 110-120 volts alternating current (AC). T/C units operating on 210-220 volts AC on DC are available for overseas or other assignments as necessary. A converter is required to use direct current. To reduce the possibility of electric shock, T/C units repaired at the Center for Plant Health Science & Technology (CPHST) have been converted from the standard two-prong plug to a polarized

plug. Extension wiring and gas sampling line length should be kept to a practical minimum and should be raised above floor level when feasible.

Measuring Gas Concentrations With the Standardized Unit

As a protection for the cell and the pump of T/C units, a drying tube should be used at all times.

In making gas concentration checks, the unit is first warmed up for 15 to 30 minutes depending on ambient temperatures. The pump is then turned on and the gas flow meter adjusted to a 1 cubic foot per hour flow. Should the scale needle seem unstable and wander for a short period of time, the flow rate may be reduced slightly below the 1 cubic foot per hour level for zeroing and maintained at that level for measuring. The unit is now ready to measure gas samples drawn through position tagged tubes from the area being treated. The needle will indicate gas concentrations in ounces per 1,000 cubic feet (grams per cubic meter).

Sufficient time to draw a true sample must be allowed. With 150 to 200 feet of 1/4 inch OD tubing and a temperature of 70°F, this will be approximately 7 minutes. Stations equipped with small, auxiliary pumps can draw a sample through the same length of tubing in 12 to 15 seconds.

Readings should be constant for at least 30 seconds before the line is disconnected. As each sampling tube is disconnected from the T/C set and the needle begins to recede toward zero, a new sampling tube may be attached. It is not necessary to wait for the needle to return to zero after each reading.

Re-zeroing the instrument is generally not needed during the course of a fumigation, except under the following circumstances:

- The pump has been turned off for an hour or more since the last reading. (Be sure to warm up the unit for 15-30 minutes before taking the next reading.) During fumigations of 6 hours or less, it is recommended that the unit be kept running constantly.
- Fresh Drierite® has been added to the gas drying tube.
- The weather during the fumigation has drastically changed since the last reading.

The gas concentration readings indicated by the T/C unit's meter will generally be more accurate if the temperature of the gas mixture within the fumigated enclosure is approximately equal to that of the ambient air outside the enclosure. If there are great differences between the two temperatures, water vapor may condense inside the gas sampling leads. Such condensation, if desiccant is saturated, can result in a lower than normal T/C meter reading, thus leading to the unnecessary addition of fumigant to compensate for the apparent

shortage. Therefore, if vapor condensation appears inside the gas sampling leads, purge the line and move the T/C unit to a new location where the ambient temperature approximates that of the enclosure.

T/C gas analyzers are sensitive to a number of gases other than MB. For example CO_2 may be troublesome when fumigating fruit where kerosene heaters are placed under the tarpaulin to raise pulp temperatures, or with plant material packed in peat moss or subsoil. Correct MB gas concentration readings may be obtained if a CO_2 absorbent is used in the gas sampling line before the air-gas mixture enters the T/C unit. A CO_2 absorbent which may be used is Ascarite®. Inspectors using Ascarite® should observe the poison warning labels on the containers. Drying tubes containing the granules should be clearly labelled "**Warning—Avoid contact with skin, eyes, and clothing.**"

After the final reading has been taken, the unit should be thoroughly purged by disconnecting from the sampling tube and allowing the pump to draw fresh air through the instrument for several minutes.

Repair and Calibration

The T/C unit will hold its calibration for a considerable length of time under normal service. To ensure that all units are providing accurate gas concentration readings, T/C units should be recalibrated at least annually; calibrate more often if use is frequent.

The instrument should be sent by Priority Mail or Air Parcel Post directly to the manufacturer or an ouside contractor. Prepare a memorandum to accompany each instrument explaining the need for sending the unit. Ensure all instruments are shipped with a proper return address, name of a contact person, and telephone number.

The T/C unit will be calibrated for MB only, unless the PPQ office requests calibration for SF. **Notify the contractor if Ascarite® will be utilized during the readings, as the T/C must be calibrated using this type of absorbent.** All port locations will be responsible for payments to contrators.

Use one of the following contractors for repair and calibration:

Key Chemical and Equipment Co. (BPA# 45-6395-3-2872)
13195 49th St. North
Unit A
Clearwater, FL 33762
tel (727) 572-1159
fax (727) 572-4595
($50.00 plus shipping per unit calibrated)

Cardinal Professional Products (BPA# 45-6395-3-2871)
2641 W. woodland Drive
Anaheim, CA 92801
tel (714) 761-3292
fax (714) 761-2095
($55.00 plus shipping per unit calibrated)

Maintenance

The T/C unit requires the same attention as any other equipment if it is to function properly. While the instrument is designed specifically for field use, the components, particularly the meter, may be damaged easily. Careful handling is essential to maintain an instrument capable of accurate gas concentration readings. If repairs are needed and are extensive, or the parts are not readily available, there will be a delay in returning the instrument. Should the need for a substitute T/C unit occur, the port should be prepared to obtain one from another source.

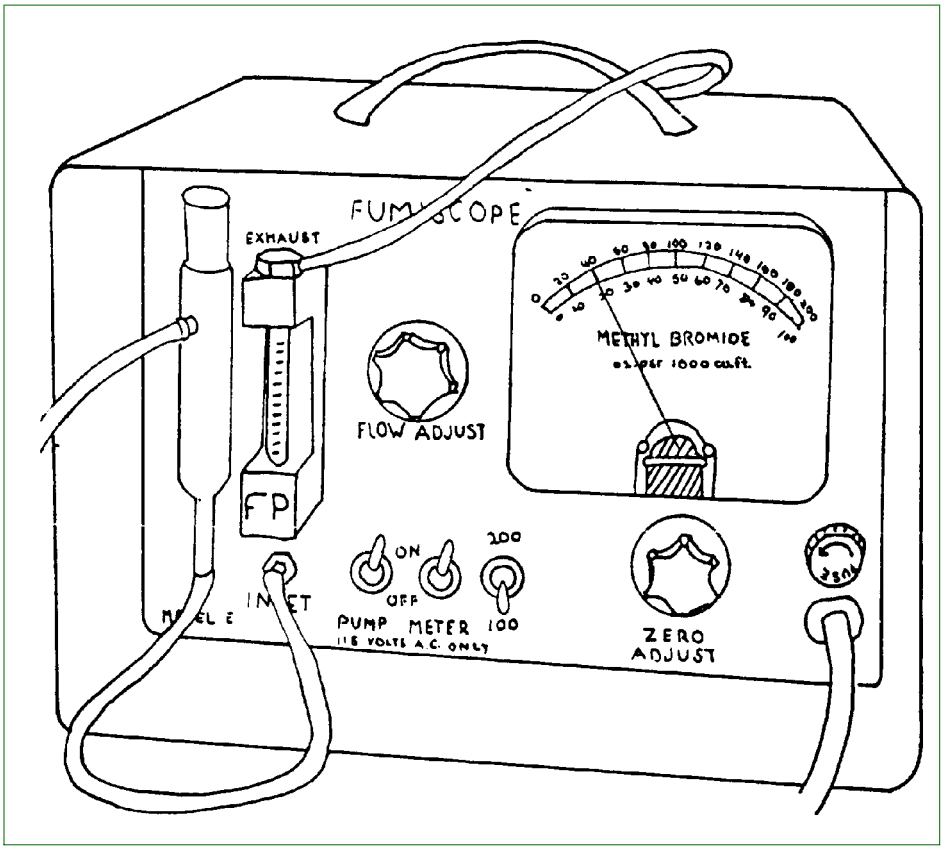


FIGURE 8-1-1: Fumiscope reading of 20 ounces per 1,000ft^3

Halide Detector

The halide gas detector has a long history of commercial usage as a leak detector for halide refrigerant gases. For fumigations, the halide detector has been used both as a leak detector to locate fumigant leakage around chambers, application equipment, temporary enclosures, and as a safety device around fumigation sites. It is also used to indicate freedom from gas concentrations of MB which may be absorbed from treated commodities. As a precautionary safety measure, it should be used regularly in rooms in which MB chambers and MB treated commodities are stored or located.

Principles of Operation

The halide gas detector is used to indicate the presence and approximate concentration of MB or other halogenated compounds in the air. This is accomplished by passing the air-gas mixture over a red hot copper plate or cone through or over which a flame is passing. The color and its intensity imparted to the flame indicates the presence and concentration of the halide gas.

Since the detector will react with other halide gas such as Freon™, a simple demonstration can be shown in the laboratory or office in the following manner:

1. Insert a funnel in the end of the detector search hose.
2. Light the unit (see the following section on Usage).
3. Direct a small amount of Freon™ propelled aerosol across the mouth of the funnel (aerosols used in PPQ aircraft treatments may be used).
4. A blue-green flame will be produced by the Freon™ gas as it contacts the heated reaction plate demonstrating what will occur when MB or other halogen gas is present.

Description

Basically, all halide detectors are quite similarly constructed, differing only in detail by the various manufacturers. Each consists of a fuel tank, a valve assembly to regulate fuel flow, a burner head assembly where the fuel and air mix and unite, the reaction plate or cone assembly where the visible flame reacts in color to the halogen fumigants. The air mixture to be tested is fed to the burner head assembly by an attached search hose.

The halide detector is relatively trouble free. The burner head orifice is extremely small and must be kept free of clogging with dust or other debris. The reaction plate or cone needs to be replaced when it becomes heavily corroded or burned.

Usage

The halide leak detector is made operable by holding a lighted match in the window opening of the burner tube and turning the valve slowly to the left. After the reaction plate or cone has heated to a red hot color, the flame should be adjusted to the minimum size to maintain that color. The detector is now ready for use. This is accomplished by holding the open end of the search hose in, on, or near the area or article to be tested. As the air sample thus drawn into the burner passes over the heated reaction plate or cone, the flame color changes if MB or any other halogen is present.

Since the operating halide leak detector contains an open flame, there must be strict adherence to obvious safety principles. Even when not in operation, it is advisable not to store the detector in a frequently inhabited room, the fuel being a flammable gas under compression.

The following are the approximate MB concentrations associated with the color intensity of the flame:***

TABLE 8-1-1: Approximate MB Concentration Associated with Flame Color

PPM*	Oz/1,000 ft^3**	Flame color
0	0.0	No color change***
25	0.1	Faint fringe of green
50	0.2	Moderate green
125	0.5	Green
250	1.0	Strong green
500	2.0	Strong green-blue fringe
800	3.2	Strong blue-green
1,000	4.0	Blue

*Threshold limit value for MB for exposure for 8 hours is 5 ppm.
**oz/1,000 ft^3 = mg/liter = g/m^3.
***Propane gas burns with a light blue flame when MB (methyl bromide) is not present.

This table of flame colors for various ppm's of MB holds good only when the detector is operated at its most sensitive rate; i.e., when the flame is reduced to the lowest rate sufficient to keep the reactor plate or cone red hot. Also, particularly when using the detector at night, the flame has a bluish cast which must be taken into consideration.

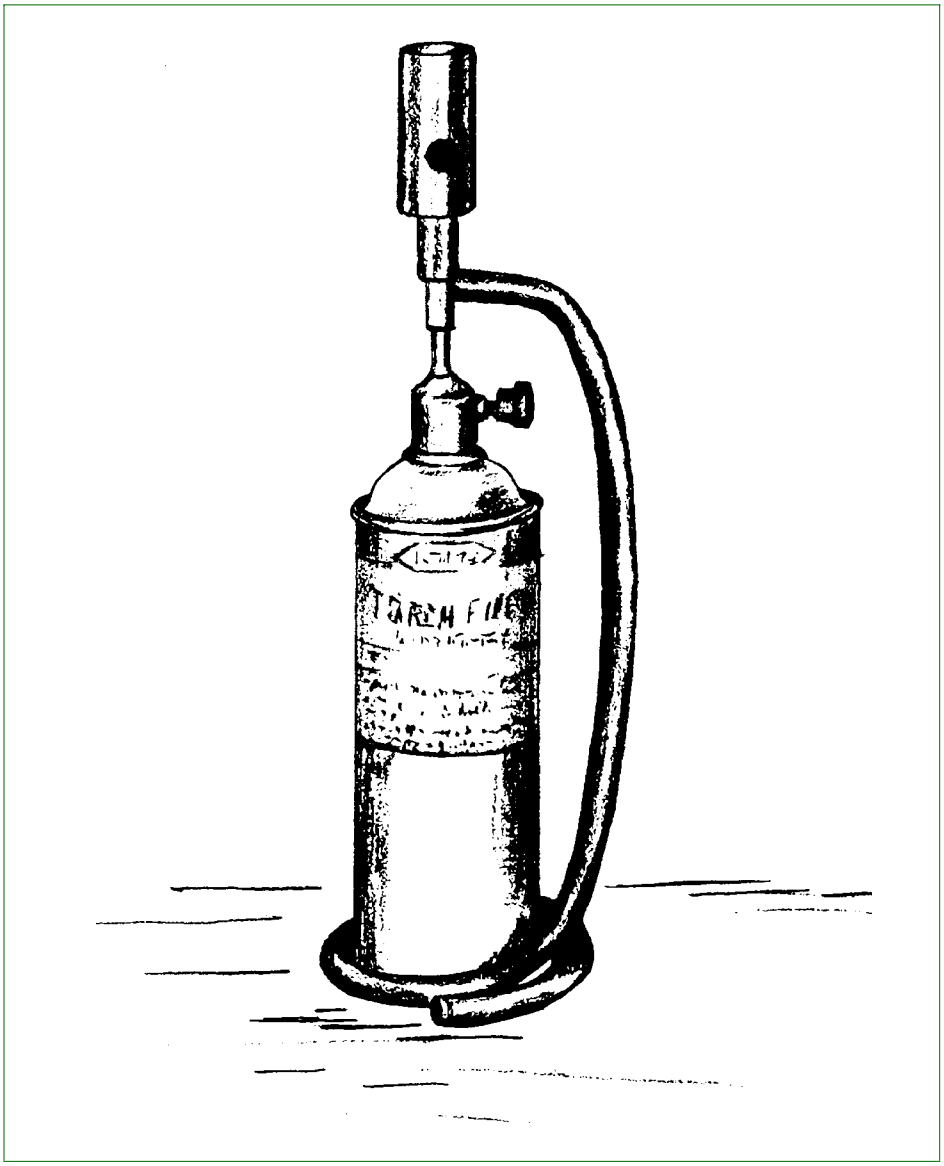


FIGURE 8-1-2: Halide Gas Leak Detector Using Disposable Propane Tank

Respiratory Protection

Introduction

Fumigation or other treatments conducted under the monitored conditions stated in this Manual and other program manuals, are safe operations. The Occupational Safety and Health Administration (OSHA) has ruled that employees with possible exposure to pesticides (including fumigants) shall be provided adequate respiratory protection from such exposure. This section discusses the types, capabilities, limitations, and uses of different respiratory protection available.

Responsibility

Management's Responsibilities

1. Provide respiratory protective equipment when such equipment is necessary to protect the health of the individual.
2. Provide equipment which is applicable and suitable for the purpose intended.
3. Establish a maintenance program for respiratory devices used.
4. Initiate and maintain a regular training program to inform personnel of basic and current information.

Officer's Responsibilities

1. Use and maintain respiratory equipment in accordance with instructions written in this manual and other instructions issued. Adherence or nonadherence to prescribed instructions for the proper use of protective devices and equipment will be a factor in evaluating the quality of an employee's performance. Gross disregard for safety measures may result in disciplinary action. A proper respiratory protection unit is required at the treatment site.
2. Report any damage or malfunction of the device to management.
3. Carry out routine cleaning and care in accordance with instructions in this manual or instructions provided by the manufacturer.

TABLE 8-1-2: Threshold Limit Values of Fumigants

Toxicity	Threshold limit value
Methyl bromide (MB)	5 ppm (skin)* STEL** and ceiling
Sulfuryl fluoride (SF)	10 ppm STEL**; 5 ppm TWA***
Phosphine (PH)	1 ppm STEL**; 0.3 ppm TWA***

*Skin means the potential overall exposure includes absorption through the skin and mucous membranes.
**Short term exposure limit
***Time-weighted average

General

For Fumigants

Every effort will be made by management and workers to prevent exposure of PPQ personnel to atmospheres containing dangerous concentrations of toxic fumigants or other pesticides, or to atmospheres where there is an oxygen deficiency. However, if an emergency situation develops where personnel may be exposed, only respiratory protective equipment with a pressure-demand regulator shall be used. This includes self-contained breathing apparatus (SCBA), air supplied respirators, and units combining these two types. (In this manual the term “SCBA” may be read to include all three of these types.) The pressure-demand respirator affords the best protection currently available because positive air pressure is maintained in the full face mask at all times.

For Pesticides Other Than Fumigants

When there is doubt as to the selection of proper respiratory protection in either of the following categories, the device which offers the best protection must be used. The determination of the type can be made by consulting this manual, the pesticide label, and the supervisor.

Air Purifying Respirators

Air purifying respirators using either a full face mask or half face mask are acceptable in areas where concentrations below maximums designated on the canisters can be expected. They may also be used during application of pesticides with a toxicity or concentration known to pose little or no danger when applied correctly.

Dust Masks

Dust masks may be used when particulate matter such as dust, insect scales, aerosol, spray, or other particles are a nuisance and are of low or moderate toxicity.

Employee Acceptance

The wearer’s acceptance of respiratory protection depends on facepiece comfort, clear and full vision, weight of the device, breathing resistance, individual physical condition, and personal preference. If more than one device with the proper facepiece seal is approved for the conditions, then the most comfortable device may be used by the

individual. PPQ will use only respiratory protective equipment tested and certified by the National Institute for Occupational Safety and Health (NIOSH), and carrying an approval number prefixed by "TC."

Capabilities and Limitations

Self-Contained Breathing Apparatus (SCBA)

Breathing air is carried in a tank by the user. When properly fitted and used according to instructions, the positive pressure-demand system will prevent harmful contaminants from entering and will provide breathing air in low oxygen areas. A warning device indicates when the air supply is low and allows adequate time for leaving the area. The individual must know that only 5 to 7 minutes air remain at the alarm and that a proper evacuation route must be planned in advance. Each unit should be tested to determine the time remaining at the sound of the alarm.

Limitations

The time which the device will provide respiratory protection is limited by the amount of air in the tank. Rapid breathing due to stress will use the air supply more quickly. There is no protection against skin irritation from toxic gases with the self-contained breathing apparatus. Since some chemicals such as HCN or pesticide groups like the organo-phosphates can be absorbed through the skin, splashes of liquid fumigants or other pesticides must be avoided and protective clothing worn to protect against accidental exposure.

Gas and Vapor Removing Respirators

Canisters and cartridges can be used as protection from most pesticides *other than fumigants*. The type of canister must be selected for a specific gas or vapor or combinations of gases or vapors. These devices have the advantage of being small, light, and simple in operation.

Limitations

Canisters and cartridges are not effective in oxygen-deficient atmospheres. There is no protection from skin irritations or absorption of pesticides through the skin. The capacity of the cartridge or canister determines the maximum contaminant concentration against which a purifying respirator will protect. The maximum concentration for which a canister is designed is printed on the label. Cartridges do not have this information. No protection is provided against particulate contaminants, unless specified on the canister or cartridge label.

The unit will not provide full protection unless the facepiece is carefully fitted to the wearer's face. The time during which protection is provided is dependent on canister or cartridge type concentration of the contaminant, and the wearer's respiratory rate.

A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air. However, this characteristic should not be relied on as an indicator of canister performance. An uncomfortably high canister temperature usually indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

Particulate Removing Respirators

Particulate removing respirators may be used only to protect against nonvolatile particles. No protection is afforded against gases and vapors unless a special combination filter and chemical cartridge (canister) system is used. The filter or cartridge shall be replaced when breathing becomes difficult due to plugging by retained particles. Combination respirators using both chemical and mechanical filtering systems are used for dual or multiple exposures to dust and vapors. Normally, filters used for removing dust, mist, or other particulates plug up before the chemical cartridge is exhausted. Both filter and chemical cartridge should be replaced at the same time.

Selection of Respiratory Protection

Work time, including the time necessary to enter or leave a contaminated area, determines the length of time for which respiratory protection is needed. The selection of respirators must be based on all hazards to which the wearer may be exposed.

The only unit with an adequate warning device is the SCBA. The SCBA is equipped with a pressure gauge and audible alarm device. Canisters may have a window indicator which only indicates the presence of moisture. Because canister and cartridge respirators have no indication of remaining service life, used canisters and cartridges should be replaced after each use.

The more active the wearer is, the more rapid his breathing. This shortens the usable working time of all types of respirators. High breathing resistance of air-purifying respirators under conditions of heavy work can result in distressed breathing.

Use of Respirator Protection

Assignment of Respiratory Protection

Every effort will be made to avoid the need for respirators. The supervisor issuing respirators shall be adequately trained to ensure that the correct respirator is issued for each type of possible pesticide exposure. Pesticide labels must be followed regarding respirator use unless more rigid standards are specified by PPQ.

If an officer will use a respirator, the supervisor must ensure that a physician or other licensed health care professional apply one or more of the following tests to determine the officer's fitness to use a respirator:

- Pulmonary Function Test
- Chest X-ray
- EKG
- Examination of nasal passages

Any such examination should be requested and reported as outlined in Section 7.2.8 of the Animal and Plant Health Inspection Service (APHIS) Safety and Health Manual. Use APHIS Form 29 for this purpose. Only a physician or other licensed health care professional can judge whether an officer is physically able to wear a respirator.

Supervisors must ensure that employees who use respirators complete a medical review every 2 years or more frequently if there is a significant change in the medical or physical condition of the officer. Procedures for conducting this review are outlined in Change No. 5 of the APHIS Safety and Health Manual, dated 2/7/86.

Use in Dangerous Atmospheres

In situations where employees may be overcome by a toxic or oxygen-deficient atmosphere, at least one additional person qualified in the use of respirators (such as the commercial applicator) shall be present. The commercial applicator and the employee should cooperate to limit the likelihood of exposure of both individuals at one time. All precautions shall be followed to prevent exposure to any individual at a treatment site. Should exposure occur and an employee be overcome by a toxic atmosphere, rescue should not be attempted without the SCBA.

Facepiece Fitting

All respirator or SCBA wearers must receive prior fitting instructions from their supervisors, fumigation trainers, or others experienced in these procedures. By demonstrations and practice, the wearer will know how to wear the respirator, how to make adjustments, and how to determine correct fit.

Even the same individual fit can vary over time due to weight loss or gain, hair, and scars. Supervisors will schedule periodic fittings to ensure that officers are diligent in observing these conditions. With ideal wearing conditions, leakage may be as low as 1 percent. The wearer must check facepiece fit according to manufacturer's facepiece fitting instructions each time respiratory protection is put on.

Inward leakage is one of the most important considerations in selecting a facepiece. Since conditions such as growth of beard, sideburns, a skull cap that projects under the facepiece, temple pieces of eyeglasses, or the absence of one or both dentures may prevent obtaining an effective face seal, they must be corrected so an effective seal is obtained. Having a clean shaven area for an effective seal, removal, or repositioning of a skull cap, use of an eyeglass adapter kit (contact lenses may not be worn during fumigations), or inserting dentures are some ways which must be used to correct these conditions. Long sideburns, beards, and other facial hair in the sealing area does prevent an effective seal even for positive pressure masks, and is in violation of the Occupational Safety and Health Administration (OSHA) regulations. Since the presence of facial hair in the sealing area is in direct violation of the OSHA regulations and also creates a significant safety hazard for the employees and their co-workers, the sealing area of the face will be cleanly shaven to permit an effective seal. All supervisors and employees must be advised of this policy.

Important

The proper seal can also be attained with a hooded pressure demand SCBA designed to fit over beards and glasses, such as, Survivair's Puma™, which is NIOSH-certified and OSHA-compliant.

All personnel assigned fumigation and/or pesticide duties wear SCBA's during critical portions of treatment procedures and must not have any condition(s) which prevent obtaining an effective face seal. Individual face masks, available in small, medium, and large sizes may be assigned.

Facepiece Fit Tests

The facepiece fit must be checked by the wearer each time the respiratory protection is used. This will be done by following the manufacturer's facepiece-fitting instructions. Two simple field tests are described below.

Negative Pressure Test

Close off the inlet opening of the facepiece or the canister or cartridges by covering with the palm of the hand(s). Inhale gently so that the facepiece collapses slightly and hold your breath for 10 seconds. If the facepiece remains in a slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is probably satisfactory.

Also, leakage can be detected by crushing an ampoule of isoamyl acetate and passing it 1 to 2 inches around the seal area and exhalation valve. In this case, leakage will be noted by a “banana-like” odor in the facepiece. (see Isoamyl acetate in Appendix H, Reference Guide to Commercial Suppliers of Treatment and Related Safety Equipment.)

Positive Pressure Test

Close the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slightly positive pressure can be built up inside the facepiece without any evidence of outward leakage of air along the seal. For most respirators, this method of leak testing requires that the wearer remove the exhalation valve cover and then be sure to carefully replace it after the test. The exhalation valve cover must be replaced the correct way to prevent affecting the rubber valve.

Special Problem

Corrective Lenses With Full Facepiece

All facepieces will restrict, to some degree, the wearer’s vision. This will increase accident potential. A proper seal cannot be established if the temple bars of eyeglasses extend through the sealing edge of the full facemask. A prescription spectacle kit for respirators is available to correct this problem. All personnel who must wear prescription eyeglasses must use this kit when wearing equipment with a full facepiece.

It is APHIS policy to supply this adapter kit to all personnel requiring one.

Wearing of contact lenses in contaminated atmospheres with a respiratory protection device is prohibited.

Eyeglasses With Half Facepiece

If corrective eyeglasses or goggles are required, they shall be worn so they do not affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

Use in Low Temperatures

The use of full facepieces at low temperatures presents problems such as poor visibility and freezing of exhalation valves. All full facepieces are designed so that the incoming fresh air sweeps over the inside of the lens to reduce fogging. This makes it possible to wear a full facepiece in ordinary room temperatures without severe fogging. Antifog compounds can be used to coat the inside of the lens to prevent fogging at room temperatures and down to temperatures approaching 32°F. However, below 0°F, antifog compounds will not prevent severe fogging.

Although such instances are not usually encountered, the employee should be aware that it is dangerous to work at temperatures near freezing and below when using respirators not designed for such use.

When using air supplied respirators, the high-pressure connections may leak because of metal contraction at low temperatures. It is important to remember that connections should not be over tightened since they may break when temperatures return to normal.

Communications

The conventional respirator exhalation valve will provide a pathway for some speech transmission over short distances in relatively quiet areas. Talking can induce facepiece or component leakage and, therefore, should be limited while wearing a respirator, especially those with half-facepiece.

Maintenance and Care

Equipment must be properly maintained to retain its effectiveness. A program for maintenance and care include the following basic services:

- Inspection for defects (including leak checks)
- Cleaning and disinfecting
- Repairs
- Storage
- Respirable air for SCBA

Inspection

The user shall inspect the respiratory equipment before and after each use. Respiratory equipment that is not routinely used, but is kept ready for emergency use, shall be inspected at least monthly to ensure that it is in satisfactory working condition. SCBA air cylinders shall be fully charged according to the manufacturer's instructions.

Inspection shall include:

1. Check tightness of connections.
2. Check the condition of the facepiece, headbands, valves, connecting tube, and any canisters or cartridges.
3. Check rubber or other elastic parts for pliability and signs of deterioration.
4. Check the regulator and the warning device to determine proper functioning before each use.
5. Check for leaks.

Keep a record of inspection dates and findings in the unit carrying case.

Cleaning and Disinfection

Clean and disinfect routinely used equipment after each use and those not routinely used as necessary to ensure that proper protection is provided for the wearer. The following is recommended for cleaning and disinfecting respiratory protection devices:

1. Remove any filters, cartridges, or canisters.
2. Wash facepiece and breathing tube with a cleaner-disinfectant or detergent solution (see following paragraphs). Use a hand brush to facilitate removal of dirt.
3. Rinse completely in clean, warm water.
4. Air dry in a clean area.
5. Clean other parts as recommended by manufacturer.
6. Inspect valves, headstraps, and other parts. Replace with new parts when defective. Stretching and manipulating rubber elastomer parts with a massaging action will keep them pliable and flexible and prevent them from warping or sticking during storage.
7. Insert new filter, cartridge, or canister in the unit. Make sure seal is tight.

Cleaner-disinfectant solutions containing a bactericidal agent (generally a quaternary ammonium compound) are available.

Commercial products must be used according to the label to obtain the proper solution. However, different concentrations of the quaternary ammonium salt are required for various hardness of water to obtain a satisfactory disinfectant solution. Dermatitis may occur if the quaternary ammonium compounds are not completely rinsed from the facepiece and associated parts.

Strong cleaning and disinfecting can damage parts. Avoid temperatures above 120°F and vigorous mechanical agitation. Solvents which affect elastomer or rubber parts must be used with caution.

Respiratory protective equipment may be contaminated with toxic materials such as organo-phosphates or other pesticides. If the contamination is light, normal cleaning procedures should provide satisfactory decontamination. If contamination is heavy, a separate decontamination step may be required before cleaning. For complete decontamination of phosphate pesticide residues, wash with alkaline soap, rinse with clean warm water and then rinse with 50 percent alcohol (ethyl or isopropyl).

If commercial materials are not available, respiratory equipment may be washed in a liquid detergent solution, then immersed in one of the following:

- Sodium hypochlorite solution (50 parts per million of chlorine) for 2 minutes; **OR**
- An aqueous iodine solution (50 parts per million of iodine) for 2 minutes; **OR**
- A quaternary ammonium solution with 200 parts per million of quaternary ammonium compounds in water of less than 500 parts per million total hardness (see Quaternary Ammonium in Appendix H, Reference Guide to Commercial Suppliers of Treatment and Related Safety Equipment.)

The sodium hypochlorite and iodine solutions are not stable. You must prepare fresh solution for each use. These solutions age rubber parts and are corrosive to metallic parts, therefore, immersion times should not be extended and the disinfectants should be thoroughly rinsed from all parts with clean, warm water.

Repair

Only experienced persons shall handle replacements or repairs using only those parts specifically designed for the equipment. Make no attempt to replace components or to make adjustments or repairs beyond the manufacturer's recommendations. Reducing or inlet valves and regulators shall be returned to the manufacturer or sent to a trained technician for adjustment or repair.

Storage

After inspection, cleaning, and necessary repair, equipment shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respiratory equipment located at stations and work areas for emergency use should be stored in compartments built for that purpose. They should be clearly marked and quickly accessible at all times. Under no circumstances shall a motor vehicle be used for storage of respiratory protective equipment. The excessive and uncontrollable changes in temperature are bad for this equipment.

Routinely used respirators, such as dust respirators, may be placed in resealable plastic bags or heat sealed plastic. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons and plainly marked. Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position to prevent function impairment by the elastomer taking a permanent set in an abnormal position. It is advisable to rotate the respirator face up, or face down at monthly inspections. Instructions for proper storage of emergency respirators, or self-contained breathing apparatus are found in “use and care” instructions usually mounted inside the carrying case lid. Should the case not have such instructions, obtain them from the manufacturer and place in the case cover.

Respirable Air for Self-Contained Breathing Apparatus

Compressed air shall be of high purity. Breathing air shall meet the requirements for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Air tanks can be refilled at most SCUBA diving stores or where local fire departments or rescue squads obtain air for their units. Test data denoting the quality of the compressed air should be available from the air supplier.

There is no need to change the air in the units, even after extended periods of time.

Never use compressed oxygen! (Compressed air may contain a low concentration of oil. When high-pressure oxygen passes through an oil or grease coated orifice, an explosion or fire may occur.)

Have breathing air cylinders inspected and hydrostatically tested as required by the type of cylinder being used. Refer to the manufacturer’s recommendations and comply with the Department of Transportation (DOT) or Interstate Commerce Commission Specifications for shipping containers.

Breathing air cylinders shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained.

Detector Kits or Gas Samples

Gas detector (colorimetric) tubes are used to measure gas concentration levels in parts per million (ppm). Concentrations of phosphine and some other fumigants cannot be measured with a T/C unit. However, they may be measured with detector tubes. Residual gas concentrations (less than 1 ounce/1000 cubic feet) during aeration of commodities or enclosures can also be determined for most fumigants with detector tubes.

Principles of Operations

Special pumps are used to draw a measured sample (usually 100 milliliters) of an air-gas mixture. The sample is drawn through one or two detector tubes where a chemical reaction with the tube reagent takes place, creating a stain. The length of the stain is proportional to the concentration of the gas. Measurement of the length of the stain is made using a calibrated chart or by simply reading the number from a scale printed on the glass tube.

Gas detector tubes are manufactured with a constant reagent weight with corrections for variations in the diameter of each tube. Detailed operational instructions accompany the equipment.

The detector tubes are specific for each fumigant and usually are available from several manufacturers. However, it is advisable to use the pump supplied by the manufacturer of the tube used. In an emergency, detector tubes available under the trade names of Auer, Draeger, Gastec, Kitagawa, and Mine Safety Appliances can be used with pumps manufactured by any of these companies provided they draw 100 ml. Adapters may be necessary because of the different diameters of the tubes sold by each manufacturer. The Kitagawa pump uses a removable, stainless-steel micro-orifice to reduce the rate of air flow through many of their detector tubes. This is to provide greater accuracy in the chemical reaction within the tube. The orifice should be removed when using tubes manufactured by other companies.

Tubes should be stored under refrigeration to increase shelf life. Before each day's use, pumps should be tested as provided by instructions with each kit and repairs made as necessary. Spare parts and operational instructions should be kept with each kit for use as needed.

When many samples must be drawn to a common point during a large fumigation, an auxiliary pump can be used. If only one sample lead is involved, it may be necessary to pull the fumigant through the line by pumping several times. A used tube can be inserted in the pump to determine when the fumigant has reached the pump.

Volatilizer

Methyl bromide must pass through a volatilizer (vaporizer) to ensure adequate conversion of liquid MB to gaseous MB. The volatilized fumigant should be introduced into or near to the air flow of the gas introduction fan. When 5 pounds or less of MB are used, a simple volatilizer can be made with a 25-foot coil of 3/8 inch O.D. coiled copper tubing immersed in a container of hot water. When amounts greater than 5 pounds are to be used, the copper tubing used in the volatilizer must consist of a minimum of 50 feet of 1/2 inch O.D. coiled copper tubing immersed in a container of hot water. The water in all sizes of volatilizers must be heated to temperatures of 200F or above with a minimum of 150F during the gas introduction process. A calibrated thermometer must be used to determine the water temperature. The thermometer must be calibrated once per year by an approved calibration company or by the fumigator under the supervision of PPQ. Written documentation of calibration must be present at the time of fumigation.

The line that runs from the from MB cylinder to the copper tubing in the volatilizer must be a 3000 PSI hydraulic high pressure hose with a 3/8 inch diameter ID (inner diameter) or larger. The line that exits the volatizer and runs into the enclosure must be a 350 PSI tubing with a 1/2 inch diameter ID or greater.

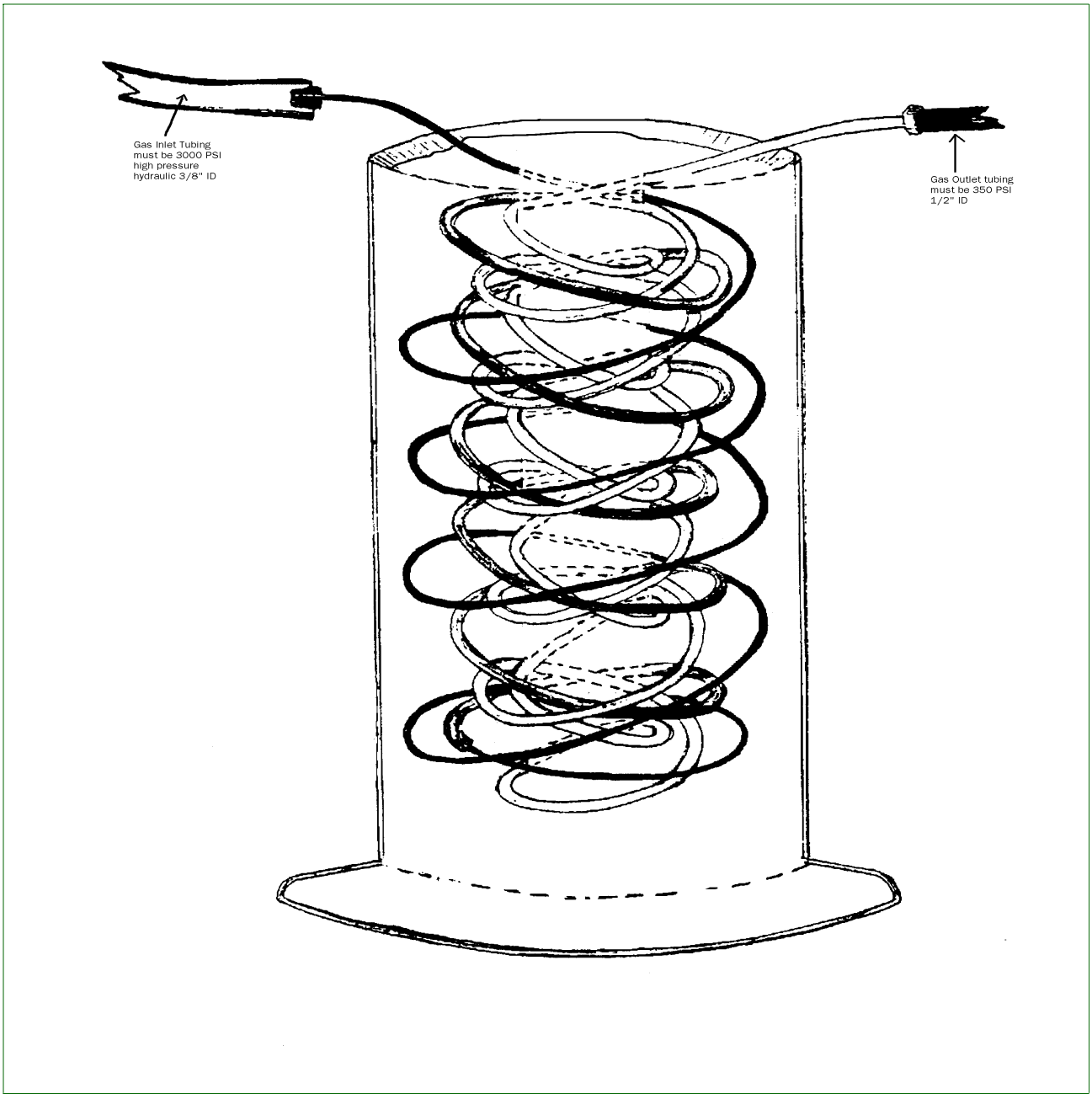
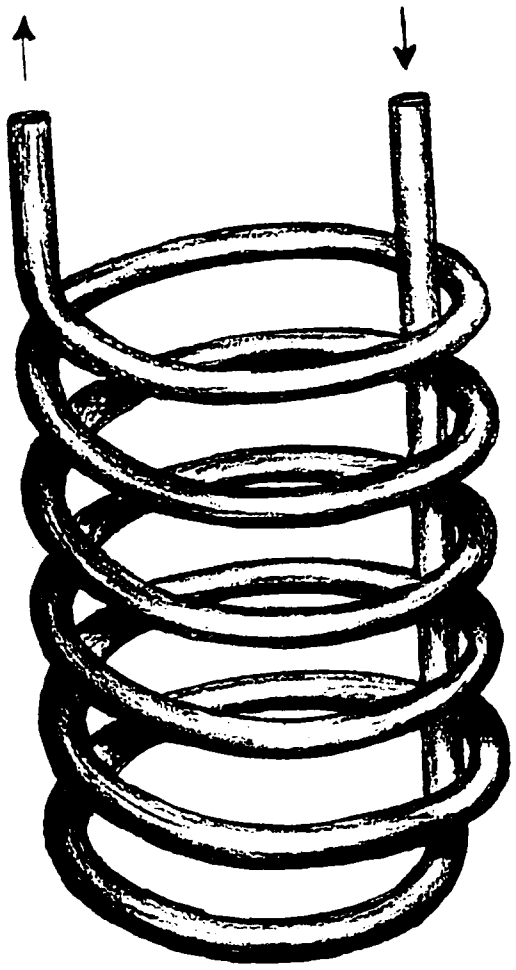


FIGURE 8-1-3: Tubing Specifications

The fumigant should be introduced through the tubing at the rate of 3 to 4 pounds of gas per minute. The gas introduction tube should feel hot to the touch as a good measure of satisfactory vaporization.



The volatilizer should be made of semihard copper tubing. It is important that gas be introduced and discharged as shown by arrows. If applied in reverse order, it may move so rapidly that some liquid will pass into the chamber.

FIGURE 8-1-4: Methyl Bromide Volatilizer Coil

Air Velocity Measuring Instruments

Anemometer

The cubic feet per minute (cfm) of a fan can be approximated by use of an anemometer or other wind measuring device. Measurements of air movement are taken 12 inches from the face of the fan to be tested. A minimum of three readings should be taken; one from the center and the others from points toward the outside of the fan. Readings are

then averaged. If an anemometer is used, each measurement should be for 1 minute, thereby giving the result in feet per minute. If a wind speed indicator is used, the reading in miles per hour should be converted to feet per minute by multiplying the miles per hour by 5,280 and dividing by 60.

Area of the fan is calculated by first measuring the radius (R)—distance from center of fan to end of a blade. Formula for area is $Pi*R^2$ where Pi is equivalent to 3.1416 (22/7). The final answer should be given in cfm. Therefore, if the radius of the blade is given in inches and not feet, the factor 1/144 must be multiplied in to convert square inches to square feet. The full formula would be: Feet per minute $\times$ R^2 (in inches) $\times$ Pi $\times$ 1/144 = cfm.

EXAMPLE: If average air movement is 1,600 feet for 1 minute from a fan having a 7 inch radius (14 inch diameter), the calculations are as follows:

$$1{,}600 \times 7^2 \times 3.1416 \times 1/144 = 1{,}700 \text{ cfm (approximate)}$$

Velometer

The Velometer is the registered trade name of Illinois Testing Laboratories, Inc., Chicago, Illinois, for their air speed indicators. Readings are taken by either holding the instrument itself or jets (probes) in front of the air stream. Velocities are rapidly determined in units of feet per minute without timing or calculations. Units are especially useful for measuring air flow in ducts and in front of grilles.

Auxiliary Pump

During the fumigation of large enclosures, it is necessary to take numerous gas concentration readings from various locations throughout the enclosure. Thus some sample leads may be over 200 feet long. The fumigant must be pumped to the sampling point before an accurate concentration reading can be made. If the inspector must rely on the pump provided with the gas sampler or thermal conductivity unit to pull the fumigant, a great deal of time will be needed between readings.

The auxiliary pump will reduce sampling time to only the reading time since it pumps the fumigant from many areas and keeps a constant pull. Construction of a unit is relatively simple. Petcocks capable of accepting sample leads are tapped and soldered to a short length of pipe. This pipe is connected to the suction side of the pump. The pipe acts as a manifold. Opening or closing the petcocks allows the drawing of the gas samples as required. An exhaust line of sufficient length should be connected to the pump to ensure the fumigant is removed from the sample area.

It is important that all soldering be done in such a manner as to provide gas tight construction of the petcocks. The pump should be of sufficient size to pull 1 cubic foot per minute through all of the leads on the manifold. Therefore, the more leads, the higher the required capacity of the pump. The whole unit should be mounted on a board large enough to keep vibration to a minimum. The unit weight should be kept down to allow easy transport.

Each sampling line is disconnected from the auxiliary pump in turn, and the petcock closed. Line is then attached to the T/C unit or gas detector. A reading is obtained and line reconnected to the auxiliary pump and the petcock opened.

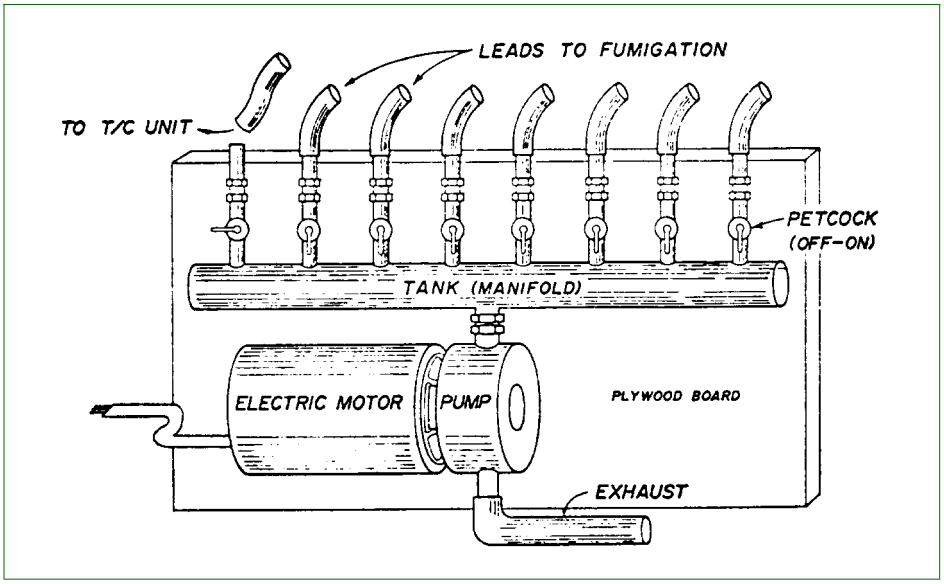


FIGURE 8-1-5: Auxiliary Pump

Open Arm Manometer

The manometer is a U-shaped tube partially filled with kerosene or water. The tube may be of glass or transparent plastic tubing. A ruler calibrated in millimeter (mm) divisions or carefully measured lines on a background is used to measure the difference in level of the kerosene in the two arms (or the level in one arm).

When a fumigant is volatilized in a chamber at atmospheric pressure, a positive pressure is created, which may then be continuously reduced by leakage of the air-fumigant mixture. PPQ approved chambers must be sufficiently tight to retain the fumigant during the exposure period. The manometer is used during the pressure-leakage test as a measure of tightness. An opening (usually 1 inch diameter) should be provided in the chamber for the use of a blower or other means for the introduction of air to create a positive pressure in the

chamber. An additional opening, such as a gas sampling line opening, must be provided for the manometer. The procedure for testing is as follows:

- Close chamber as for fumigation
- Attach one end of the manometer to the chamber opening
- Use vacuum cleaner blower or similar apparatus to create pressure of 25 mm as measured on an open-arm, kerosene or water filled manometer
- Discontinue blower and close its entry
- Observe time for pressure to recede from 25 to 2.5 mm in the open arm

The time lapse for the chamber pressure to recede from 25 to 2.5 mm in the open arm must be 22 or more seconds for minimum approval. Chambers shall be reinspected every 6 months when 22 to 29 seconds are recorded. Chambers which retain the pressure for 30 seconds or longer should be tested annually. (Chambers used for fumigating cherries for export to Japan are required to meet a higher standard—the time lapse for the chamber pressure to recede from 25 to 2.5 mm must be 60 or more seconds for minimum approval.) Inability to develop or maintain adequate pressure indicates considerable leakage. In such cases, the chamber operator may use a smoke bomb or other device in an effort to determine the areas of leakage.

Electronic manometers are also available and may be used in lieu of the Open-arm (U-tube) type.

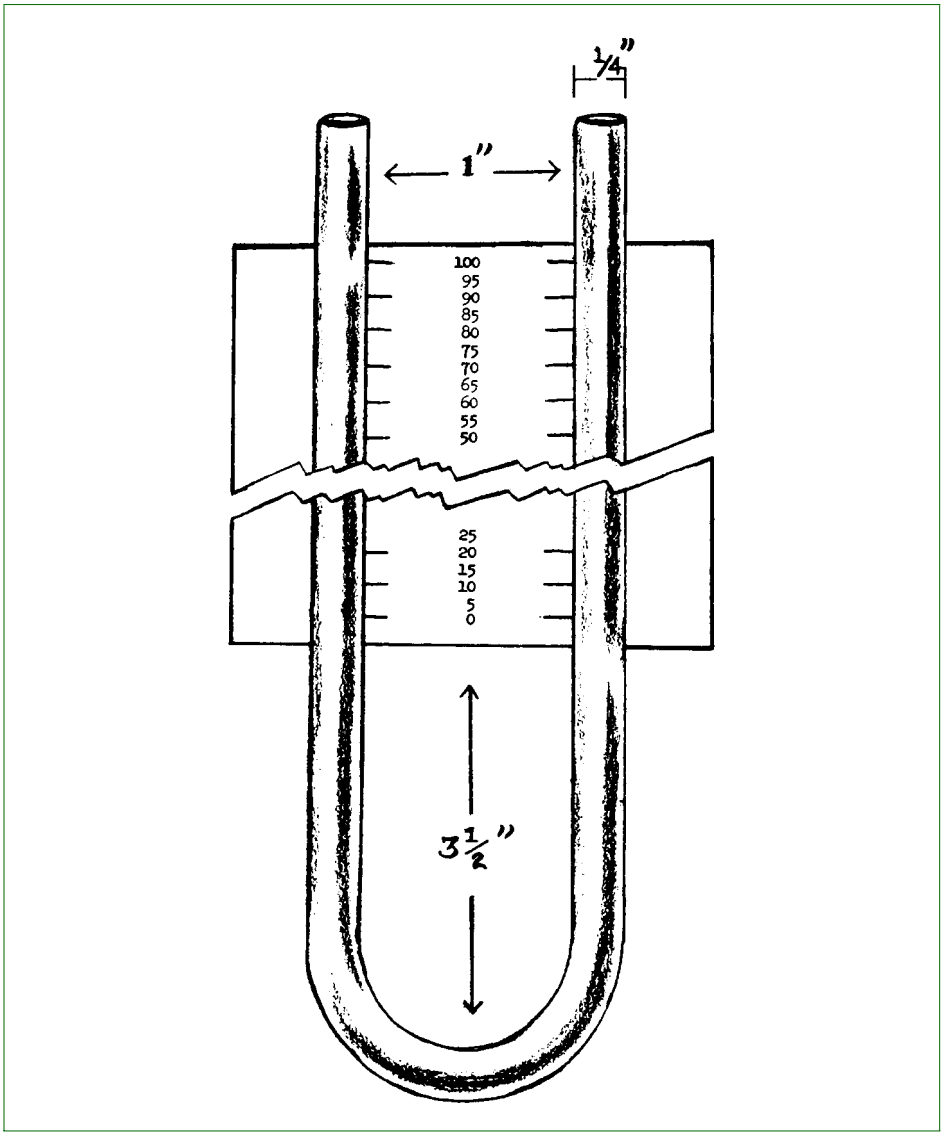


FIGURE 8-1-6: Open-arm Manometer

Vacuum Pump

Mityvac Hand-Held Vacuum Pump

The Center for Plant Health Science and Technology has developed the following procedure to detect blocked monitoring leads with the use of a Mityvac hand-held vacuum pump (for supplier, see *Vacuum Pump*, Appendix 8):

Usage

1. Prior to fumigant introduction, connect the Mityvac hand-held vacuum pump to a monitoring lead.
2. Squeeze the handle on the Mityvac Unit. If the lead is blocked, a vacuum will be indicated on the vacuum gauge of the Mityvac unit. (The handle should be squeezed two or three times for monitoring leads longer than 25 feet. The Mityvac hand-held pump has the capacity to attain and hold 25 inches of Hg vacuum and a minimum of 7 psi pressure.)
3. Disconnect the Mityvac hand-held pump from the monitoring lead, and repeat this procedure for each monitoring lead. (Connect monitoring leads to the gas analyzer prior to fumigant introduction.)

Phosphine Detector

PortaSens Phosphine Detector

Description

Historically, phosphine measurements have been done using detector tubes specific for phosphine (see **Detector Kits or Gas Samplers** in this section). The high cost associated with these tubes have been a deterrent for many ports.

A more accurate, portable unit has been recommended for usage during phosphine fumigations. The Series B16 PortaSens is a portable, battery operated instrument for the measurement of various gas concentrations in ambient air. The instrument can be ordered specifically for phosphine in the 0-1,000 ppm range. Ranges from 0-1 ppm are available also, along with other configurations. The PortaSens is a complete measuring instrument containing an electrochemical sensor, sampling pump, flow cell assembly, microprocessor electronics, and a two line backlit LCD display. The unit is powered by a rechargeable NiCad battery located in the handle, with the charger connection located at the bottom of the handle.

Operation

The PortaSens needs to be calibrated by the Center for Plant Health Science & Technology (CPHST) before usage. After calibration, the instrument is ready to use directly out of the box. Simply remove the instrument from the storage case and press and release the button (instrument switch) on the front of the handle. The LCD display on the front will immediately be activated and the internal pump will begin to pull sample into the flow cell.

The unit comes with a flexible extension wand that screws into the standard inlet fitting. Connect the extension wand and a length of flexible tubing that will reach safely from the item(s) being fumigated to the PortaSens.

Response Time

Response time will vary depending on the gas concentration and ambient temperature. The LCD readout will stabilize when maximum concentration is reached. Readings will be more timely when the monitoring leads are purged using the Mityvac hand held vacuum pump (refer Mityvac Hand-Held Vacuum Pump).

Alarm Function

The PortaSens contains both visual and audible gas concentration alarm functions that are preset at the factory. Refer to B16 PortaSens Operation and Maintenance Manual for specific instructions. For instruments in the 0-1,000 ppm range, the alarm has been disabled to allow for more efficient usage.

Battery Power Supply

The instrument is powered by a rechargeable NiCad battery. With a fully charged battery, the unit will operate continuously for 12 hours at 20°C. Battery capacity will drop with decreasing temperature. Should the battery become weak during operation, the lower line of the LCD display will indicate “LOW BATT.” An audible beeper will begin to sound. At this point, there will be 1 hour of operating time left. When the voltage reaches a level where reliable measurements are no longer possible, the unit will turn itself off. It is good practice to leave the instrument on charge at all times if emergency use is anticipated.

Flow Verification

Proper flow should always be verified before using the PortaSens for leak detection. When the unit is turned on, a pump continuously delivers an air sample to the flow cell. In normal operation, the flow rate is approximately 300 cc/min. In order to allow quick verification of proper flow, a flowmeter is included in the PortaSens kit. Turn the instrument on and connect the sampling wand. Place the tip of the sampling wand into the tubing adapter attached to the flowmeter. Hold the flowmeter in the vertical position and verify that the flow rate is above 150 cc/min.

Power Down

In order to turn the unit off, press and hold the switch for approximately 3 seconds, until the “POWER DOWN” message appears on the display and then release.